

# Conservative treatment versus percutaneous intramedullary pinning for acute tendinous mallet finger: Does pin configuration matter?

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## ABSTRACT

**BACKGROUND:** Acute tendinous mallet finger (Doyle type I) is commonly treated with continuous immobilization of the distal interphalangeal (DIP) joint; however, treatment success largely depends on patient compliance. Percutaneous intramedullary (IM) Kirschner wire DIP joint transfixation represents a minimally invasive surgical alternative, although the clinical relevance of different pin configurations remains unclear. This study compared conservative and surgical treatment methods and evaluated the impact of different pin configurations on clinical outcomes.

**METHODS:** This retrospective cohort study included 93 adult patients with acute tendinous mallet finger who presented within 7 days of injury and were followed for at least 12 months. Patients were allocated into three groups: conservative treatment with a tape-reinforced Stack splint (n=33), percutaneous IM Kirschner wire DIP joint transfixation with the pin left exposed (n=30), and IM transfixation with the pin buried within the fingertip pulp (n=30). The primary outcome was residual DIP joint extension lag at final follow-up. Secondary outcomes included functional results according to the Crawford criteria and treatment-related complications.

**RESULTS:** Baseline DIP extension lag did not differ significantly among the groups (p=0.801). At final follow-up, residual extension lag was significantly greater in the conservative group (median 4°) compared with the surgical groups (0.5° and 1°, respectively; p<0.001). Multicategorical analysis of Crawford grades showed no significant intergroup difference (p=0.095); however, dichotomous analysis (excellent + good outcomes) demonstrated significantly higher success rates in the surgically treated groups compared with the conservative group (p=0.014). Skin maceration was more frequent in the conservative group (p<0.001), whereas pin-site irritation was significantly more common in the exposed pin group (p=0.006). No significant differences were observed among the groups regarding superficial infection.

**CONCLUSION:** In patients with acute tendinous mallet finger, percutaneous IM Kirschner wire DIP joint transfixation provides superior extension control and higher functional success rates compared with conservative treatment. Although pin configuration does not significantly influence functional outcomes, it affects patient comfort and the complication profile. Treatment decisions should therefore be individualized based on patient compliance and functional expectations.

**Keywords:** Acute tendinous mallet finger; distal interphalangeal joint; intramedullary Kirschner wire; distal interphalangeal (DIP) joint transfixation; conservative treatment; percutaneous pinning.

## INTRODUCTION

Mallet finger (MF) is a common hand injury characterized by loss of active extension at the distal interphalangeal (DIP)

joint, resulting from either rupture of the terminal extensor tendon or an avulsion fracture at the dorsal base of the distal phalanx (Fig. 1).<sup>[1]</sup> Although MF injuries are frequently encountered in patients presenting to emergency depart-

Cite this article as: Kaya O, Malkoç F, Ümit M, Kazez M. Conservative treatment versus percutaneous intramedullary pinning for acute tendinous mallet finger: does pin configuration matter? *Ulus Travma Acil Cerrahi Derg* 2026;32:702-714.

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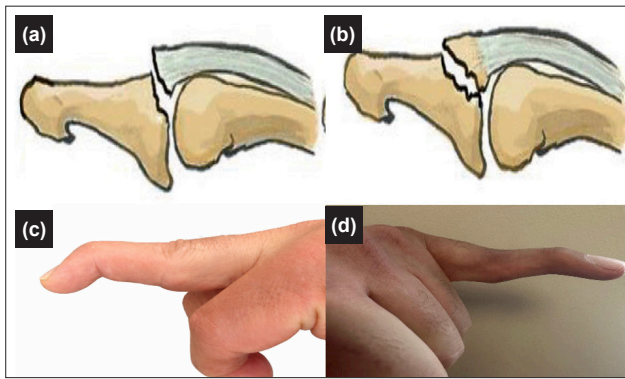
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*Ulus Travma Acil Cerrahi Derg* 2026;32(6):702-714 DOI: 10.14744/tjtes.2026.18598

Submitted: 24.01.2026 Revised: 10.03.2026 Accepted: 16.03.2026 Published: 03.06.2026

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**Figure 1.** Spectrum of mallet finger pathology. (a) Schematic illustration of tendinous mallet finger caused by rupture of the terminal extensor tendon. (b) Bony mallet finger resulting from a dorsal avulsion fracture of the distal phalanx. (c) Clinical appearance of acute mallet finger demonstrating loss of active extension at the distal interphalangeal joint. (d) Swan-neck deformity developing as a late complication of untreated or inadequately treated mallet finger.

ments with acute hand trauma, they may be underestimated as minor injuries or overlooked in the absence of appropriate radiographic evaluation.<sup>[2]</sup> Failure to establish an early diagnosis and initiate appropriate treatment may lead to persistent extension lag, cosmetic deformity, and late complications such as swan-neck deformity (Fig. 1), potentially necessitating more complex surgical interventions for an otherwise manageable condition.<sup>[1,2]</sup>

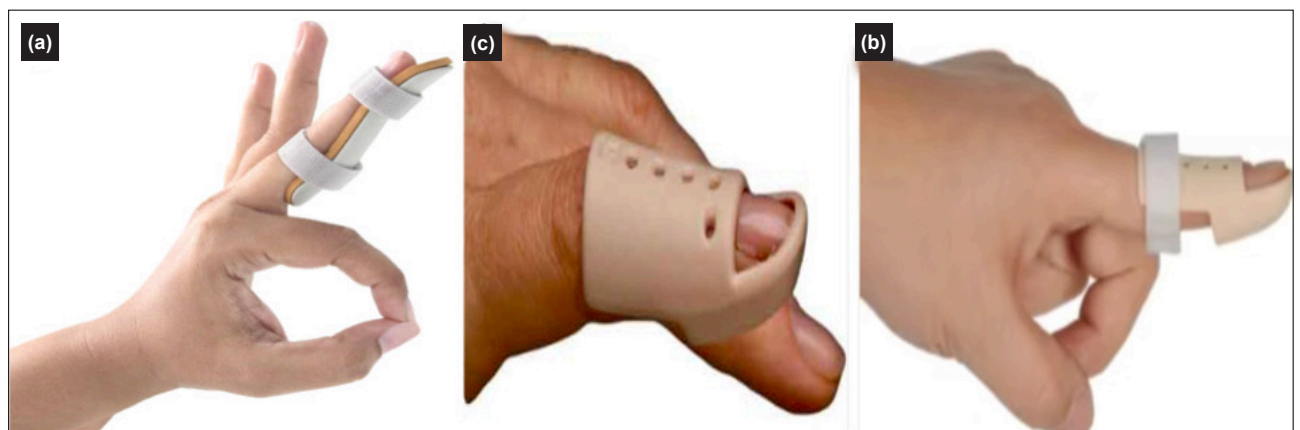
Mallet finger injuries encompass a broad clinical spectrum according to the Doyle classification, ranging from isolated soft-tissue injuries to complex lesions involving large bony fragments with DIP joint subluxation.<sup>[3]</sup> Tendinous MF (Doyle type I), which involves isolated injury to the terminal extensor tendon without an associated fracture, is the most commonly encountered form in clinical practice.<sup>[3]</sup> The mechanism of injury is typically related to low-energy trauma and most often results from sudden passive hyperflexion or hyperextension

of the extended fingertip following axial loading during daily activities.<sup>[4]</sup> Although sports-related injuries are more common in younger individuals, population-based studies indicate that household activities account for a substantial proportion of cases, particularly among middle-aged and elderly patients.<sup>[4,5]</sup>

The primary goal in the management of tendinous MF is accurate recognition in the acute phase and prompt initiation of appropriate treatment. The fundamental principle of treatment is continuous immobilization of the DIP joint in full extension to facilitate optimal healing of the terminal extensor mechanism.<sup>[6]</sup> Accordingly, conservative treatment is generally considered the first-line approach for acute Doyle type I injuries, and various extension splints are widely used.<sup>[6]</sup> However, the success of conservative treatment is highly dependent on patient compliance and the ability of the splint to maintain uninterrupted DIP joint extension.<sup>[6,7]</sup> Even brief episodes of DIP joint flexion during treatment may disrupt tendon healing and lead to treatment failure or the need for surgical intervention.<sup>[6,7]</sup> Furthermore, the requirement for prolonged immobilization, typically lasting 6–8 weeks, may reduce patient tolerance and negatively affect treatment adherence in routine clinical practice.<sup>[6]</sup>

In clinical practice, aluminum splints, classic Stack splints, and tape-reinforced Stack splints designed to enhance stability (Fig. 2) are commonly used; however, there is no clear consensus regarding the superiority of any specific splint type in terms of functional outcomes.<sup>[8,9]</sup> Current evidence suggests that patient compliance, rather than splint type, is the primary determinant of successful conservative treatment.<sup>[6]</sup>

In cases where conservative treatment cannot be maintained, or in patients with high functional demands, surgical treatment options may be considered. Fixation of the DIP joint in full extension using a Kirschner wire (K-wire) is a minimally invasive surgical technique that provides stable immobilization independent of patient compliance.<sup>[10]</sup> Compared with



**Figure 2.** Splinting methods used in conservative treatment. (a) Aluminum finger splint used for immobilization of the distal interphalangeal (DIP) joint in full extension. (b) Classic Stack splint applied to maintain continuous DIP joint extension. (c) Tape-reinforced Stack splint designed to enhance stability and improve patient compliance during conservative treatment.

open tendon repair techniques, percutaneous intramedullary (IM) pinning offers the advantages of minimal soft tissue disruption and relatively low surgical morbidity.<sup>[11]</sup> However, evidence directly comparing different percutaneous pin configurations, particularly exposed versus buried IM pinning, in patients with acute tendinous MF remains limited.<sup>[11]</sup>

The aim of this study was to compare conservative and surgical treatment methods in patients with acute Doyle type I tendinous MF and to evaluate the impact of different pin configurations used during percutaneous IM pinning on clinical outcomes. We hypothesized that surgical treatment would provide superior functional outcomes compared with conservative management and that pin configuration may influence patient comfort and complication profiles.

## MATERIALS AND METHODS

### Study Design and Ethical Approval

This retrospective observational cohort study was conducted at a tertiary-level trauma center. The study protocol was approved by the local institutional ethics committee (session date: October 16, 2025; approval number: 2025/17-07). All procedures were performed in accordance with the ethical principles of the Declaration of Helsinki.

### Patient Selection

Patients presenting to the emergency department or orthopedic outpatient clinic with hand trauma between January 2022 and January 2025 and diagnosed with acute tendinous MF were retrospectively reviewed. The diagnosis was established based on clinical examination and standard anteroposterior and lateral radiographs of the hand to exclude associated osseous pathology. To ensure a homogeneous acute-phase cohort, only patients presenting within 7 days of injury were included.

### Inclusion Criteria

Patients meeting all of the following criteria were included:

- Age  $\geq 18$  years
- Diagnosis of acute tendinous MF
- Presentation within 7 days of injury
- Absence of bony avulsion or articular surface-involving fracture of the distal phalanx
- Completion of treatment according to the initially selected treatment modality
- Availability of clinical follow-up data for at least 12 months.

### Exclusion Criteria

Patients were excluded if any of the following criteria were present:

- Open injuries
- Bony avulsion involving the articular surface of the distal phalanx or other associated fractures

- Concomitant tendon or bone injuries involving the same finger
- Previous trauma or surgery affecting the same finger with residual functional impairment
- Noncompliance with conservative treatment requiring a change in treatment modality
- Incomplete clinical follow-up data.

### Treatment Decision Process and Group Allocation

The treatment modality was determined after all patients received standardized information regarding both conservative and surgical options. During the decision-making process, injury characteristics, the patient's clinical status, functional expectations, motivation, and occupational requirements were taken into account. All patients were evaluated using a standardized clinical decision-making algorithm.

Surgical treatment was primarily considered for patients in whom adherence to prolonged splint use was expected to be poor, those requiring early functional recovery, or individuals for whom uninterrupted immobilization was impractical due to occupational demands. Importantly, treatment selection was not based solely on patient preference; surgical intervention was performed only when deemed clinically appropriate and was confirmed by the responsible orthopedic and traumatology specialist.

After treatment initiation, patients were categorized into three groups according to the modality applied:

**Group 1:** Conservative treatment with a tape-reinforced Stack splint

**Group 2:** Percutaneous IM K-wire DIP transfixation with the pin left exposed

**Group 3:** IM K-wire transfixation with the pin buried within the fingertip pulp.

In a subset of patients initially managed conservatively, protocol deviations occurred during follow-up. These included delayed presentation beyond the acute phase, noncompliance with splint use (e.g., intermittent use, premature discontinuation, or unintended finger flexion during splint care), inadequate stabilization resulting from the use of splint types other than the tape-reinforced Stack splint, or conversion to surgical treatment for clinical indications.

To preserve treatment homogeneity in intergroup comparisons, these patients were excluded from the primary comparative analysis and classified as a separate subgroup representing conservative treatment failure (Group 4). Data from this subgroup were analyzed descriptively only.

### Radiographic Evaluation

At baseline, all patients underwent radiographic evaluation to exclude osseous pathology and associated avulsion fractures. Standard anteroposterior (AP) and true lateral radiographs (isolated lateral view of the affected finger) were obtained for

the involved digit (Fig. 3). To avoid misinterpretation due to superposition, all images were assessed with specific focus on the target finger.

As only tendinous MF cases were included in the study and intraoperative fluoroscopic confirmation was performed during percutaneous IM K-wire transfixation in the surgical groups, routine postoperative radiographic follow-up was not conducted. Instead, patients were evaluated clinically during follow-up, with emphasis on functional outcomes, wound status, pin-related complications, and maintenance of DIP joint extension.

### Preoperative Extension Lag Assessment

Active DIP joint extension lag was assessed clinically using a standard goniometer placed over the dorsal aspect of the joint, while the proximal interphalangeal (PIP) joint was maintained in a neutral position. All measurements were performed according to a standardized protocol by experienced orthopedic surgeons (Fig. 3).

### Clinical Evaluation and Outcome Measures

All patients were followed through routine clinical visits during the follow-up period, and outcome measures were assessed at the final follow-up using a standardized clinical examination protocol. Only patients with a minimum follow-up duration of 12 months were included in the analysis. This time point was selected as it represents a reliable stage at which tendinous healing is complete, residual extension lag has stabilized, and functional outcomes can be consistently evaluated.

#### Primary Outcome Measure

- Active DIP joint extension lag, measured in degrees at the final follow-up visit.

#### Secondary Outcome Measures

- Functional outcomes at final follow-up assessed according

to the Crawford classification criteria

- Treatment-related complications, including:
  - o Skin maceration
  - o Nail deformity
  - o Pin-site irritation
  - o Superficial or deep infection
  - o Permanent extension lag
  - o Swan-neck deformity.

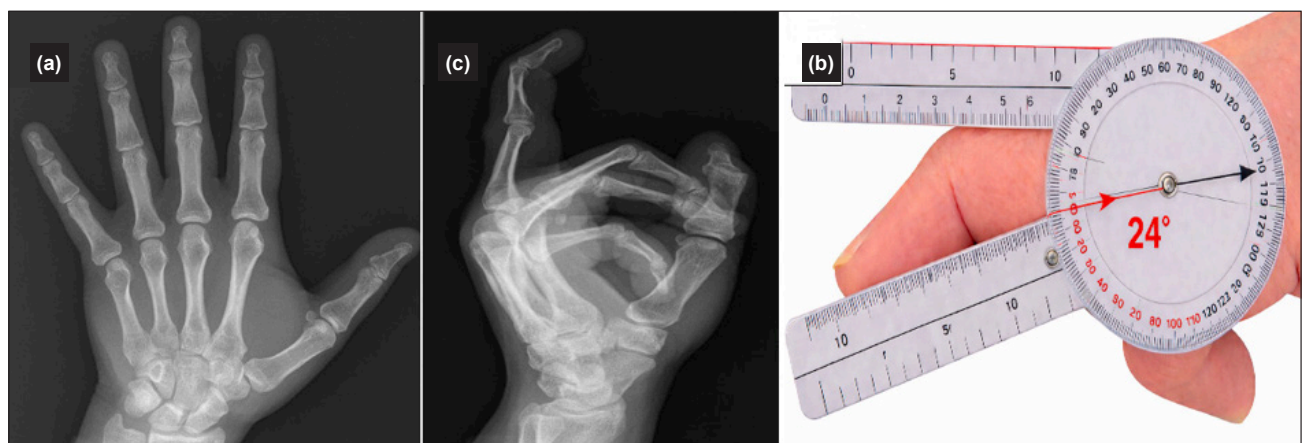
All clinical evaluations were performed by orthopedic and traumatology specialists experienced in hand surgery, using a standardized measurement protocol to ensure consistency across assessments.

### Conservative Treatment Protocol

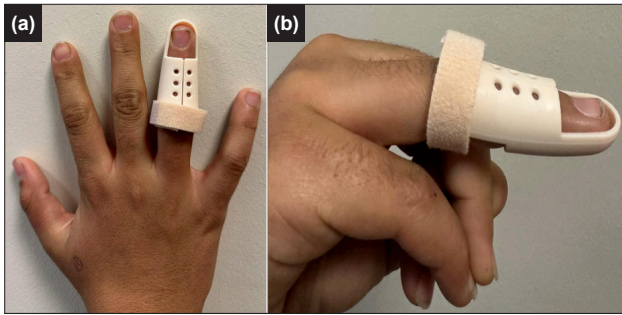
Conservative treatment was applied to patients with acute tendinous MF who were either not considered suitable candidates for surgery or preferred nonoperative management (Group 1). The primary goal of conservative management was continuous immobilization of the DIP joint in full extension to facilitate healing of the terminal extensor tendon at an appropriate length and tension.

A tape-reinforced Stack splint was used in all conservatively treated patients (Fig. 4). The splint was applied to maintain the DIP joint in full extension while allowing free motion of the PIP joint. The tape-reinforced Stack splint was preferred over conventional Stack or aluminum splints due to its improved stability and lower risk of displacement during daily activities.

Patients were instructed to wear the splint continuously for at least 8 weeks, 24 hours per day. Emphasis was placed on the importance of uninterrupted immobilization, as even brief removal of the splint or unintended DIP joint flexion could



**Figure 3.** Baseline radiographic and clinical assessment of acute tendinous mallet finger. (a) Standard anteroposterior radiograph of the affected digit obtained at initial presentation to exclude bony injury and avulsion fractures. (b) True lateral radiograph confirming the absence of osseous pathology and isolated tendinous involvement. ©Standardized clinical measurement of active distal interphalangeal (DIP) joint extension lag using a goniometer from the dorsal aspect, with the proximal interphalangeal (PIP) joint maintained in neutral position.



**Figure 4.** Conservative treatment using a tape-reinforced Stack splint. (a,b) Clinical views of Group 1 patients treated with a tape-reinforced Stack splint for continuous immobilization of the distal interphalangeal (DIP) joint in full extension.

compromise tendon healing. Patients were educated on techniques to prevent DIP flexion during necessary splint removal and received detailed instructions regarding splint care, skin hygiene, and early recognition of skin-related complications.

During the conservative treatment period, patients attended regular outpatient follow-up visits. At each visit, splint positioning, skin integrity, the presence of maceration or irritation, and patient compliance were systematically assessed. Skin maceration and splint-related irritation were recognized as common limitations of conservative treatment.

### Surgical Techniques

Surgical treatment was performed in patients with acute tendinous MF who were not considered suitable candidates for conservative management or who preferred surgical intervention. Percutaneous IM K-wire DIP joint transfixation was used as the surgical technique in all cases.

All procedures were performed in the operating room without the use of a tourniquet and under digital block anesthesia using 2 mL of prilocaine hydrochloride. A single prophylactic intravenous dose of 1 g cefazolin was administered preoperatively, and no routine postoperative antibiotic therapy was prescribed.

The primary objective of surgery was to achieve stable fixation of the DIP joint in full extension and to facilitate optimal healing of the terminal extensor mechanism. A 1.0-mm IM K-wire was used in all surgically treated cases. Hyperextension was intentionally avoided to reduce the risk of dorsal skin compromise and related complications.

### IM K-Wire DIP Transfixation Technique

With the patient in the supine position, the affected finger was prepared and draped in a sterile fashion. The DIP joint was manually positioned in full extension and maintained throughout the procedure. A 1.0-mm K-wire was inserted from the distal tip of the distal phalanx, approximately 2 mm distal to the nail plate, and advanced proximally through the IM canal of the distal phalanx into the middle phalanx, thereby stabilizing the DIP joint in extension. Proper wire place-

ment and joint alignment were confirmed intraoperatively using fluoroscopy.

### Pin Configuration and Surgical Subgroups

Surgically treated patients were further divided into two subgroups based on the configuration of the distal end of the IM K-wire used for DIP joint transfixation.

#### Group 2: IM K-Wire DIP Transfixation with the Pin Left Exposed

In this group, the distal end of the K-wire was left external to the skin. The exposed portion of the wire was bent to maintain stability and protected with a sterile dressing (Fig. 5). Postoperatively, patients received standardized instructions regarding pin-site care and dressing changes.

The main advantage of this technique is the ease of pin removal under outpatient clinic conditions without the need for an additional surgical procedure. However, leaving the pin exposed may be associated with disadvantages such as pin-site irritation or superficial infection, the need for regular dressing changes, and discomfort due to snagging during daily activities. Therefore, all patients received detailed education regarding pin-site care and hygiene.

#### Group 3: IM K-Wire DIP Transfixation with the Pin Buried within the Fingertip Pulp

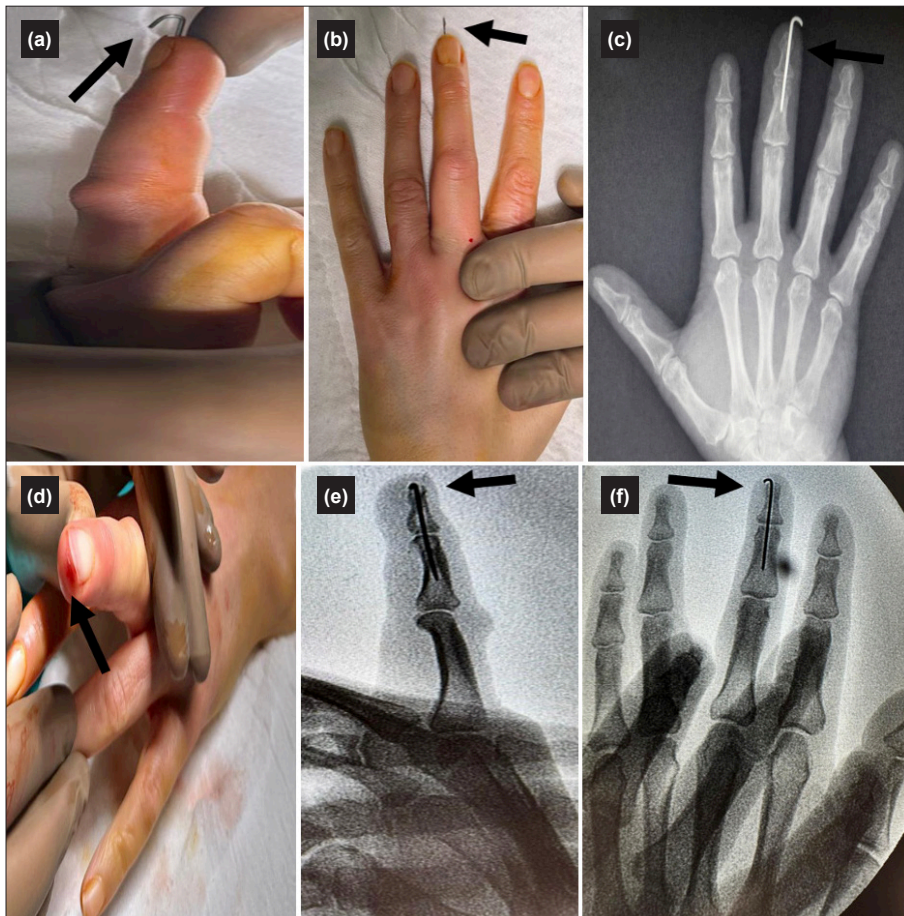
In this group, the distal end of the IM K-wire was bent and embedded within the fingertip pulp of the distal phalanx. The K-wire length ensured adequate retention for possible subsequent removal. After trimming to the appropriate length, the wire was inserted subcutaneously through a minimal skin incision (Fig. 5), thereby eliminating contact between the pin and the external environment. Suturing was not required due to the small size of the incision.

This technique was employed to reduce pin-site irritation, eliminate the need for routine dressing changes, prevent discomfort from snagging during daily activities, and facilitate an earlier return to daily and occupational functions.

### Postoperative Care and Rehabilitation

In both surgical groups, no additional external splint was applied postoperatively, as the DIP joint was stably fixed using IM K-wire for DIP transfixation. Patients were advised to avoid active DIP joint motion during the early postoperative period; however, early free motion of the PIP and metacarpophalangeal joints was permitted. During follow-up visits, pin stability, wound condition, and potential complications were assessed using a standardized clinical examination protocol.

In the group with the pin left exposed, patients received standardized instructions regarding pin-site care and dressing changes. In contrast, patients with pins embedded within the fingertip pulp were followed clinically without the need for routine dressing changes, as the minimal incision typically healed rapidly.



**Figure 5.** Percutaneous intramedullary (IM) pinning techniques and pin configurations. **(a)** Lateral clinical view after percutaneous pinning with the K-wire left exposed (Group 2). **(b)** Anteroposterior clinical view with arrows indicating the exposed distal end of the K-wire. **(c)** Anteroposterior radiograph demonstrating IM fixation with an exposed pin configuration. **(d)** Clinical photograph showing a minimal pulp incision in a patient treated with a buried pin configuration (Group 3). **(e)** Lateral radiograph demonstrating IM pinning with the distal end buried within the pulp. **(f)** Anteroposterior radiograph showing stable IM fixation with a buried pin configuration.

IM K-wires were routinely removed under outpatient conditions at approximately 6 weeks postoperatively, based on clinical healing and functional recovery. Following pin removal, no additional immobilization was applied, and patients were encouraged to gradually resume daily activities within pain tolerance.

However, activities placing excessive stress on the DIP joint, including forceful gripping, heavy lifting, repetitive flexion, and trauma-prone activities, were restricted for approximately 2 weeks after pin removal. Hand exercises, as well as return to occupational and sporting activities, were gradually permitted according to clinical recovery and functional status, with supervised rehabilitation provided when necessary.

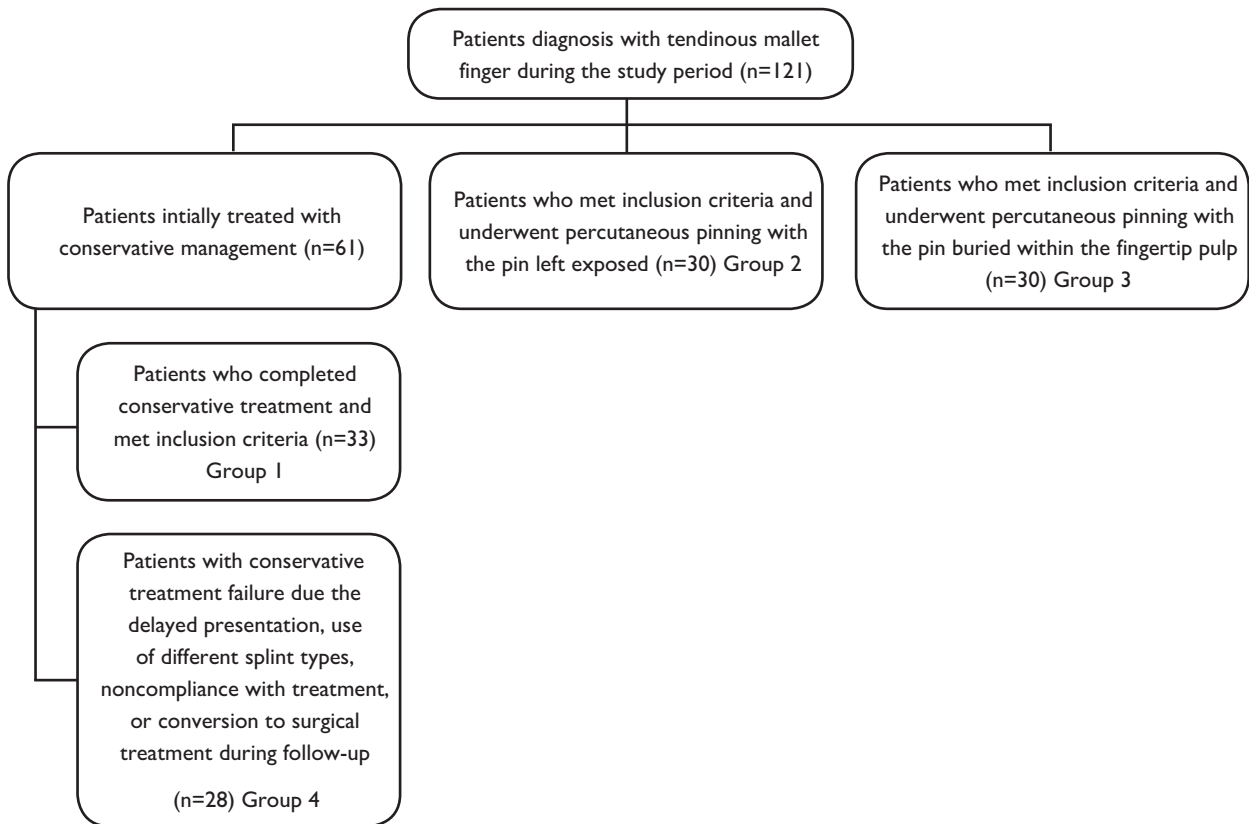
### Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro-

Wilk test and visual inspection methods, including histograms and Q-Q plots. Continuous variables that were not normally distributed are presented as median and interquartile range (IQR), whereas categorical variables are expressed as counts and percentages (%).

Comparisons among the three treatment groups (conservative treatment with a tape-reinforced MF splint, IM K-wire DIP transfixation with the pin left exposed, and IM K-wire DIP transfixation with the pin buried within the fingertip pulp) were performed using the Kruskal-Wallis test for continuous variables. When a statistically significant difference was detected, pairwise comparisons were conducted using Dunn-Bonferroni corrected post hoc analyses.

Functional outcomes were evaluated according to the Crawford criteria using both multicategorical (excellent/good/fair/poor) and dichotomous classifications to enhance clinical interpretability (successful: excellent + good; unsuccessful: fair



**Figure 6.** Study flow diagram. Flowchart illustrating patient selection, application of inclusion and exclusion criteria, and allocation into treatment groups. Of 121 patients diagnosed with tendinous mallet finger, 93 met the inclusion criteria and were included in the comparative analysis. Patients with failed conservative treatment were excluded from intergroup comparison and are reported as a separate descriptive subgroup (Group 4).

+ poor). Due to low expected cell counts in some categories, categorical variables were compared between groups using the Fisher–Freeman–Halton exact test, and exact p values were reported.

Residual DIP joint extension lag was compared among groups and further analyzed in relation to Crawford functional outcomes using Spearman's correlation analysis.

For all statistical tests, a p value <0.05 was considered statistically significant.

## RESULTS

### Patient Flow and Study Population

During the study period, a total of 121 patients who presented to the emergency department or orthopedic outpatient clinic with acute hand trauma and were diagnosed with tendinous MF were retrospectively evaluated. After applying the inclusion and exclusion criteria, 93 patients constituted the final study population and were allocated into three groups according to the treatment modality:

- **Group 1:** Conservative treatment with a tape-reinforced Stack splint (n=33)

- **Group 2:** IM K-wire DIP transfixation with the pin left exposed (n=30)

- **Group 3:** IM K-wire DIP transfixation with the pin buried within the fingertip pulp (n=30).

A post hoc power analysis indicated that a sample size of 93 patients provided 85% statistical power to detect differences in the primary outcome (Kruskal–Wallis test;  $\alpha=0.05$ , effect size  $f=0.35$ ).

Of the 61 patients initially assigned to conservative treatment, 28 (45.9%) experienced conservative treatment failure due to protocol deviations or noncompliance. To preserve intergroup homogeneity, these patients were excluded from the comparative analyses and evaluated separately as a descriptive subgroup (Group 4).

The patient selection process, application of inclusion and exclusion criteria, and distribution of patients across treatment groups are illustrated in Figure 6.

### Demographic and Clinical Characteristics

The median age of the 93 patients included in the study was 44 years (IQR: 36–52). Thirteen patients (14.0%) were male and 80 (86.0%) were female. The fourth finger was the most

**Table 1.** Demographic and baseline clinical characteristics of the treatment groups

Characteristic	Group 1 (n=33)	Group 2 (n=30)	Group 3 (n=30)	p value
Age (years), mean±SD	43.6±10.9	44.2±11.5	44.1±11.2	p=0.91
Female sex, n (%)	28 (84.8)	26 (86.7)	25 (83.3)	p=0.88
Male sex, n (%)	5 (15.2)	4 (13.3)	5 (16.7)	
Affected finger n (%)				
Fourth finger	16 (48.5)	14 (46.7)	15 (50.0)	p=0.74
Third finger	9 (27.3)	8 (26.7)	10 (33.3)	
Second finger	5 (15.2)	5 (16.7)	4 (13.3)	
Fifth finger	3 (9.0)	3 (10.0)	1 (3.3)	
Dominant hand in-involvement, n (%)	23 (69.7)	21 (70.0)	22 (73.3)	p=0.80
Injury mechanism, n (%)				
Daily activities	26 (78.8)	22 (73.3)	21 (70.0)	p=0.57
Sports-related injury	7 (21.2)	8 (26.7)	9 (30.0)	
Time to presentation (days), mean±SD	3.1±1.5	2.9±1.3	3.0±1.4	p=0.83

frequently affected digit, followed by the third, second, and fifth fingers. Injuries involved the dominant hand in approximately two-thirds of cases. The fourth finger was the most commonly affected digit across all groups, with no significant intergroup difference ( $p=0.74$ ).

Most injuries resulted from low-energy trauma during daily activities, whereas sports-related injuries were more common in younger patients. The median time from injury to presentation was 3 days (IQR: 2–4).

No statistically significant differences were observed among the treatment groups with respect to age, sex, affected finger distribution, dominant hand involvement, injury mechanism, or time to presentation (all  $p>0.05$ ) (Table 1).

### Pre- and Post-Treatment Clinical Findings

At baseline, active DIP joint extension lag ranged from 20° to 35°, with a median of 30° for the entire cohort. No statistically significant difference was observed among the treatment

groups in terms of pre-treatment extension lag ( $p=0.801$ ).

At final follow-up, residual DIP joint extension lag ranged from 0° to 19°. The median residual extension lag was 4° in Group 1, 0.5° in Group 2, and 1° in Group 3.

Intergroup comparison demonstrated a statistically significant difference in residual extension lag at final follow-up (Kruskal–Wallis test,  $p<0.001$ ). Post hoc analysis revealed that patients treated conservatively had significantly greater residual extension lag compared with both surgical groups (Bonferroni-adjusted  $p<0.05$ ). No statistically significant difference was observed between the two surgical groups ( $p>0.05$ ).

These findings indicate that surgical stabilization provides superior correction of extension lag compared with conservative treatment in patients presenting in the acute phase (Table 2).

### Functional Outcomes – Crawford Evaluation

Functional outcomes were assessed at final follow-up using the Crawford criteria. Excellent results were observed

**Table 2.** Comparison of clinical outcomes among treatment groups

Parameter	Group 1 (n=33)	Group 2 (n=30)	Group 3 (n=30)	p value (between groups)	Statistical test
Pre-treatment					
DIP extension lag (°), median (IQR)	30 (20–35)	30 (22–35)	30 (23–35)	p=0.801	Kruskal-Wallis
Final follow-up DIP extension lag (°), median (IQR)	10 (5–15)	5 (0–10)	4 (0–8)	<0.001	Kruskal-Wallis
Pre- to post-treatment change (°), median	20	25	26	<0.001	Wilcoxon signed-rank
Final DIP joint flexion (°), mean±SD	50±5	45±6	45±5	p=0.28	Kruskal-Wallis

**Table 3.** Functional outcomes according to Crawford criteria and residual extension lag

Variable	Group 1 (n=33)	Group 2 (n=30)	Group 3 (n=30)	p value
Crawford grade†				0.095*
Excellent	3 (9.1)	8 (26.7)	8 (26.7)	
Good	20 (60.6)	20 (66.7)	20 (66.7)	
Fair	10 (30.3)	2 (6.6)	2 (6.6)	
Poor	0 (0.0)	0 (0.0)	0 (0.0)	
Successful outcome (excellent + good)†	23 (69.7)	28 (93.4)	28 (93.4)	0.012*
Unsuccessful outcome (fair + poor)†	10 (30.3)	2 (6.6)	2 (6.6)	
Post-treatment DIP extension lag (°)‡	10.0 (5.0–15.0)	5.0 (0.0–10.0)	4.0 (0.0–8.0)	<0.001**

Data are presented as n (%) or median (interquartile range). †Fisher–Freeman–Halton exact test; ‡Kruskal–Wallis test; \*Exact p value; \*\*Highly statistically significant at  $p < 0.001$ .

in 19 patients (20.4%), good results in 60 patients (64.5%), and fair results in 14 patients (15.1%); no patients had poor outcomes. Overall, the rate of excellent and good outcomes was 84.9%.

When functional outcomes were compared among treatment groups, the surgical groups (Groups 2 and 3) demonstrated higher rates of excellent and good outcomes compared with the conservative group, whereas fair outcomes were more common in the conservative group. However, analysis using the Fisher–Freeman–Halton exact test, accounting for the multicategorical structure of the Crawford classification, revealed no statistically significant difference in the distribution of Crawford grades among groups ( $p = 0.095$ ).

To improve clinical interpretability, Crawford outcomes were further analyzed using a dichotomous classification (successful outcome: excellent + good; unsuccessful outcome: fair + poor). Based on this analysis, the rate of successful outcomes was significantly higher in the surgically treated groups compared with the conservative group (Fisher's exact test,  $p = 0.014$ ).

Functional outcomes according to the Crawford criteria were consistent with residual extension lag measured at final follow-up, with better functional results associated with lower residual extension lag values (Table 3).

#### Complications and Treatment-Related Adverse Events

Complications and treatment-related adverse events were analyzed separately for each group. No major complications, including deep infection, permanent flexion contracture ( $>25^\circ$ ), nail bed deformity, or the need for secondary surgical intervention, were observed in any patient.

In the conservative treatment group, minor adverse events related to prolonged splint use were more frequent. Skin maceration or local irritation was observed in eight patients (24.2%), which was significantly higher than in the surgical

groups ( $p < 0.001$ ). In addition, 6 patients (18.2%) reported treatment dissatisfaction related to splint care requirements, limitations in daily activities, and delayed return to work.

In the surgical group with exposed K-wires, minor complications associated with external pin contact were predominant. Four patients (13.3%) experienced pin-site irritation and discomfort due to pin snagging during daily activities, which was significantly more frequent compared with the buried pin group ( $p = 0.006$ ). Superficial pin-site infection occurred in two patients (6.7%), all of whom were successfully managed with local wound care and a short course of oral antibiotics. No statistically significant difference was observed between groups ( $p = 0.13$ ). Overall, four patients in this group reported treatment dissatisfaction related to pin-associated discomfort.

In the buried K-wire group, no pin-site irritation or infection was observed due to the absence of external pin exposure. However, two patients (6.7%) experienced transient pulp tenderness related to the buried distal wire tip, which resolved without additional intervention. Apart from short-term sensitivity at the site of the small pulp incision during pin removal, no further complications were recorded. No patient in this group reported treatment-related dissatisfaction (Table 4).

#### Analysis of Patients with Failed Conservative Treatment (Group 4)

During the study period, 61 patients were initially managed with conservative treatment. Of these, 28 patients (45%) were excluded from the primary comparative analysis due to protocol deviations or conservative treatment failure.

Among these 28 patients, eight underwent delayed surgical intervention after the first week following injury due to unsuccessful conservative management. In an additional 10 patients, surgical treatment was recommended because of

**Table 4.** Complications according to treatment groups

Parameter	Group 1 (n=33)	Group 2 (n=30)	Group 3 (n=30)	Total (n=93)	p-value
Skin maceration	8 (24.2%)	0	0	8 (8.6%)	p<0.001
Pin-related irritation	0	4 (13.3%)	0	4 (4.3%)	p=0.006
Pulp tenderness	0	0	2 (6.6%)	2 (2.1%)	p=0.13
Superficial infection	0	2 (6.7%)	0	2 (2.1%)	p=0.13
Treatment dissatisfaction*	6 (18.2%)	4 (13.3%)	0	10 (10.7%)	—

Categorical variables were compared using Fisher's exact test. \*Due to its subjective nature, treatment dissatisfaction was reported descriptively and was not included in statistical comparisons.

inadequate clinical response; however, surgery was declined due to low functional demands or patient preference.

Noncompliance with splint use was identified as a major contributing factor in a substantial proportion of excluded patients. Specifically, 15 patients failed to maintain continuous splint use as recommended; intermittent removal of the splint, unintended finger flexion, and inadequate protection during daily activities were documented. Furthermore, 14 patients used splint types other than the tape-reinforced Stack splint. These alternative splints were considered less stable and more difficult to monitor clinically, which may have adversely affected treatment outcomes. In several cases, more than one of these factors was present concurrently.

## DISCUSSION

One notable aspect of the present study is the evaluation of clinical outcomes associated with a percutaneous IM pinning configuration in which the distal end of the K-wire is buried within the fingertip pulp in patients with acute tendinous MF. Although various surgical techniques, including open tendon repair, extension-block pinning, and percutaneous K-wire stabilization, have been described in the literature for the management of mallet finger injuries, the optimal treatment strategy for isolated acute tendinous mallet finger remains a matter of debate.<sup>[12-16]</sup> The present study therefore contributes to the existing literature by comparing conservative and surgical treatment approaches while also examining the potential impact of pin configuration within minimally invasive surgical management.

Another key finding of this study is that surgical stabilization using percutaneous pinning resulted in significantly lower residual distal interphalangeal joint extension lag and superior functional outcomes compared with conservative treatment. In contrast, no significant difference in residual extension loss was observed between the two surgical groups based on pin configuration (exposed versus buried). These findings suggest that stable fixation of the distal interphalangeal joint is the primary determinant of tendon healing and functional recovery, whereas pin configuration appears to influence patient

comfort and the complication profile rather than extension lag outcomes.

The demographic characteristics of the patient cohort in the present study are consistent with the typical patient profile reported in the literature for acute tendinous MF.<sup>[4]</sup> Previous studies have shown that MF injuries most commonly occur following low-energy trauma during daily activities and are more frequently observed in middle-aged and elderly individuals.<sup>[4,5]</sup> Rubin et al.<sup>[4]</sup> emphasized that tendinous MF injuries generally occur in older patients and are predominantly associated with low-energy injury mechanisms. Similarly, Botero et al.<sup>[5]</sup> reported in their comprehensive review that low-energy domestic trauma represents a common etiological factor in tendinous MF injuries.

The patient distribution in our study aligns with these observations and reflects a clinically homogeneous population with acute tendinous MF in terms of injury mechanism and presentation. Moreover, the absence of a statistically significant difference in pre-treatment distal interphalangeal joint extension lag among the treatment groups indicates that the groups were comparable in baseline clinical severity. In the literature, initial extension lag in acute tendinous MF is typically reported to range between 20° and 35°.<sup>[10]</sup> In the study by Nagura et al.,<sup>[10]</sup> similar baseline extension lag values were observed in both surgical and conservative groups, consistent with the pre-treatment findings of the present study.

Taken together, these observations support the interpretation that the post-treatment outcomes in our cohort are primarily attributable to the treatment modality rather than differences in baseline injury severity.

In the study by Renfree et al.,<sup>[17]</sup> conservative treatment and percutaneous pinning techniques were compared, and the authors reported superior correction of extension lag in the surgical group; however, distal interphalangeal joint flexion was slightly reduced compared with the conservative group. In the present study, a homogeneous cohort of patients presenting in the acute phase with tendinous MF was evaluated. Consistent with previous findings, better extension control

was achieved in the surgically treated groups, whereas a mild reduction in flexion was observed compared with the conservative group (mean DIP flexion: 50° in the conservative group vs. 45° in both surgical groups). However, this difference did not reach statistical significance ( $p=0.28$ ) (Table 2). Previous comparative studies have similarly shown that surgical pinning does not meaningfully compromise DIP joint flexion or overall functional outcomes.<sup>[10,17]</sup> The slight reduction in DIP joint flexion observed in surgically treated patients may be attributable to temporary joint immobilization and periarticular stiffness associated with distal interphalangeal joint transfixation.

From the perspective of patient satisfaction, Renfree et al.<sup>[17]</sup> reported that 93% of patients in the conservative group and 100% in the surgical group would choose the same treatment again. In our cohort, this rate was 81.8% in the conservative treatment group, 86.7% in the exposed pin group, and 100% in the buried pin group. These findings suggest that the buried pin configuration may enhance patient comfort and treatment acceptability, thereby improving overall satisfaction with surgical management. Patient satisfaction was assessed at the final follow-up visit through a non-standardized clinical interview, and treatment dissatisfaction was recorded descriptively, as summarized in Table 4.

Conservative treatment has long been recommended as the first-line management for patients with acute tendinous MF. However, its success is highly dependent on patient compliance, uninterrupted splint use, and appropriate splint selection. In the Cochrane review by Handoll et al.,<sup>[6]</sup> no clear functional superiority was demonstrated among different splint types; however, patient adherence was identified as the key determinant of successful treatment outcomes. Similarly, Botero et al.<sup>[5]</sup> reported that although conservative treatment is theoretically effective, failure rates increase substantially in routine clinical practice when adequate compliance cannot be maintained.

In the present study, modification of the initial treatment strategy was required in 45% of patients initially managed conservatively, either due to failure of conservative treatment or conversion to surgical intervention. This finding reflects the compliance-related challenges highlighted in the literature and underscores their clinical relevance in real-world practice.<sup>[6,7]</sup> In particular, intermittent splint use, use of splint types other than tape-reinforced Stack splints, and inadequate immobilization during daily activities were identified as key factors negatively affecting treatment success. Reported failure rates for conservative treatment vary across studies depending on the definition of failure, duration of follow-up, and level of patient compliance, with real-world series describing rates approaching 30%.<sup>[5,6]</sup> The relatively higher failure rate observed in our cohort (45%) may reflect stricter outcome definitions as well as real-world compliance challenges associated with prolonged splint immobilization. In our study, treatment failure also included protocol deviations and clinically significant

residual extension lag, which may have contributed to the higher rate compared with previously reported series.

Insufficient patient education regarding the treatment process and the critical importance of continuous splint use may be a key contributor to conservative treatment failure. Limited awareness of the potential risk of permanent finger dysfunction associated with nonadherence may further compromise outcomes. In addition, based on our clinical observations, tape-reinforced Stack splints appear to provide more stable immobilization compared with aluminum or non-taped splint designs. However, in our cohort, the use of custom-made splints was not feasible due to cost constraints and limited availability.

In the study by Karadeniz et al.,<sup>[15]</sup> no statistically significant difference was observed between conservative treatment and K-wire pinning according to the Crawford criteria. This finding suggests that multicategorical functional scoring systems may have limited sensitivity in detecting clinically meaningful differences between treatment modalities. In particular, the four-level structure of the Crawford classification may reduce statistical power in comparative analyses. In contrast, dichotomization of the Crawford scale in the present study revealed a statistically significant advantage in favor of surgical treatment, highlighting a methodological approach that improves the clinical interpretability of functional assessment.

In the present study, only acute cases presenting within the first 7 days after injury were included and managed accordingly. A follow-up duration of 12 months was selected, as it is widely accepted in the literature as a reliable time frame for evaluating long-term functional outcomes in acute tendinous MF. Previous studies have frequently reported treatment outcomes in heterogeneous patient populations comprising both bony and tendinous MF injuries with variable presentation times, and early presentation has been associated with improved functional outcomes.<sup>[8]</sup> By exclusively including patients with acute tendinous MF, the present study established a homogeneous cohort, allowing a more precise evaluation of the effect of treatment modality on functional outcomes.

The lower residual extension lag observed in surgically treated patients likely reflects the mechanical advantage of stable DIP joint fixation during tendon healing. While conservative treatment relies on uninterrupted splint use to maintain joint stability, surgical stabilization with IM pinning preserves the extension position independently of patient compliance.<sup>[10]</sup>

Nagura et al.<sup>[10]</sup> reported that residual extension lag following conservative treatment is frequently associated with splint noncompliance and early flexion stress during the healing period, providing a plausible explanation for the greater extension lag observed in the conservative group in our cohort. Although numerous surgical techniques have been described for the management of bony MF injuries, there remains no clear consensus regarding the optimal treatment strategy for Doyle type I tendinous MF, which represents the most

common clinical presentation.<sup>[1,12]</sup> This lack of standardization may complicate treatment decision-making, particularly in patients presenting in the acute phase.

In the present study, no significant difference in residual extension lag was observed between buried and exposed pin configurations; however, notable differences were identified in patient comfort and complication profiles. Exposed pin fixation was more frequently associated with pin-site irritation, a catching sensation during daily activities, the need for regular dressing changes, and superficial infections.<sup>[10,15]</sup> In contrast, the buried pin technique minimized these issues. The principal advantage of buried pinning is the absence of an externally exposed pin tip, which improves patient comfort and may facilitate an earlier return to daily and occupational activities in selected patients.<sup>[10]</sup> Conversely, the requirement for a small pulp incision during pin removal may be considered a technique-specific drawback. In our cohort, this incision resulted only in transient tenderness without permanent complications, and all pin removal procedures were performed under outpatient conditions without the need for additional surgical intervention.

The majority of complications observed in this study were minor adverse events related to patient comfort rather than major clinical complications (Table 4). In the conservative treatment group, skin maceration and treatment dissatisfaction were primarily associated with prolonged splint use and limitations in daily activities. In the exposed pin group, irritation and superficial infections were attributable to external pin exposure. In contrast, the absence of pin-tract irritation or infection in the buried pin group further supports the potential advantages of this technique in terms of patient comfort and treatment tolerability. Importantly, none of the adverse events required additional surgical intervention, and all were successfully managed with conservative measures, indicating that all three treatment strategies are generally safe.

Future prospective randomized studies are warranted to confirm these findings and further clarify the optimal pin configuration for acute tendinous mallet finger. From a clinical perspective, the buried pin configuration may be preferable in patients for whom improved treatment comfort and reduced risk of pin-related irritation are priorities, whereas the exposed pin technique may remain a practical option when ease of outpatient removal and shorter procedural time are desired.

### Limitations and Strengths

One of the main strengths of this study is the inclusion of only patients with isolated acute tendinous MF (Doyle type I), resulting in a clinically homogeneous study population. The absence of significant differences in baseline extension lag among treatment groups allows the observed outcomes to be more reliably attributed to the treatment modality. In addition, the separate evaluation of patients who initially underwent conservative treatment but later required surgical

intervention reflects real-world clinical practice and enhances the interpretability of the findings.

Another strength of this study is the direct comparison of two different IM pin configurations within the surgical treatment group. The buried pin technique, for which clinical outcome data remain limited, was specifically evaluated in terms of patient comfort, complication profile, and functional outcomes. Furthermore, dichotomization of Crawford outcomes improved the clinical interpretability of functional assessment and enabled a more meaningful comparison between treatment strategies.

Nevertheless, several limitations should be acknowledged. The retrospective design and lack of randomization may have introduced treatment selection bias related to both patient and surgeon preferences. Although treatment selection was guided by a standardized clinical decision-making process, baseline functional expectations and motivation may have influenced the preference for surgical treatment in some patients, potentially introducing additional selection bias. The relatively small sample size may limit the detection of rare complications. In addition, long-term outcomes and patient-reported satisfaction beyond one year were not evaluated. The absence of routine postoperative radiographic follow-up may have limited the detection of asymptomatic wire migration or subtle joint penetration. However, the single-center design and use of standardized surgical and follow-up protocols strengthen the internal consistency of the results. Although pin configuration did not significantly influence extension outcomes, the buried pin technique was associated with improved patient comfort and fewer pin-related complications. These findings suggest that buried pinning may be particularly advantageous in active patients requiring better treatment tolerability and an earlier return to daily activities.

### CONCLUSION

In patients with acute tendinous MF, surgical stabilization provides lower residual distal interphalangeal joint extension lag and more predictable functional outcomes compared with conservative treatment. Although pin configuration in IM pinning does not significantly influence extension outcomes, it has clinically relevant implications for patient comfort and complication profile. Percutaneous pinning with burial of the distal pin tip within the fingertip pulp offers improved patient comfort, fewer pin-related complications, and the potential for an earlier return to daily activities in selected patients. Treatment decisions should therefore be individualized based on clinical findings, expected patient compliance, and functional demands to optimize outcomes.

**Ethics Committee Approval:** This study was approved by the Elazığ Fethi Sekin City Hospital Non-Interventional Research Ethics Committee (Date: 16.10.2025, Decision No: 2025/17-07).

**Peer-review:** Externally peer-reviewed.

**Authorship Contributions:** Concept: M.K., O.K., F.M., M.Ü.G.; Design: M.K., O.K., F.M.; Supervision: M.K., O.K., M.Ü.G.; Resource: M.K., O.K., F.M., M.Ü.G.; Materials: M.K., O.K., F.M., M.Ü.G.; Data collection and/or processing: M.K., F.M., M.Ü.G.; Analysis and/or interpretation: O.K., F.M., M.Ü.G.; Literature review: M.K., O.K., F.M.; Writing: M.K., O.K.; Critical review: M.K., O.K., F.M., M.Ü.G.

**Informed Consent:** Retrospective study.

**Conflict of Interest:** None declared.

**Financial Disclosure:** The author declared that this study has received no financial support.

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## ORİJİNAL ÇALIŞMA - ÖZ

### Akut tendinöz çekiç parmakta konservatif tedavi ile perkütan intramedüller pinleme karşılaştırması: Pin konfigürasyonu önemli mi?

**AMAÇ:** Akut tendinöz çekiç parmak (Doyle tip I) olgularında tedavi genellikle distal interfalangeal (DIP) eklem uzun süreli immobilizasyonuna dayanır; ancak tedavi başarısı büyük ölçüde hasta uyumuna bağlıdır. Perkütan intramedüller (IM) K-teli ile DIP eklem transfiksasyonu cerrahi bir alternatif olarak uygulanabilmekte, ancak farklı pin konfigürasyonlarının klinik sonuçlara etkisi net değildir. Bu çalışmada konservatif ve cerrahi tedavi yöntemleri karşılaştırılmış ve farklı pin konfigürasyonlarının klinik sonuçlara etkisi değerlendirilmiştir.

**GEREÇ VE YÖNTEM:** Bu retrospektif kohort çalışmaya, yaralanmadan sonraki ilk 7 gün içinde başvuran ve en az 12 ay süreyle takip edilen 93 erişkin akut tendinöz çekiç parmak hastası dahil edildi. Hastalar üç gruba ayrıldı: Bantlı Stack ateli ile konservatif tedavi (n=33), pinin dışında bırakıldığı perkütan IM K-teli ile DIP eklem transfiksasyonu (n=30) ve pinin parmak ucu pulpası içine gömülü bırakıldığı IM transfiksasyon (n=30). Primer sonlanım ölçütü son kontrolde ölçülen rezidüel DIP eklem ekstansiyon kaybıydı. Sekonder sonlanım ölçütleri Crawford kriterlerine göre fonksiyonel sonuçlar ve tedaviye bağlı komplikasyonlardı.

**BULGULAR:** Başlangıç DIP eklem ekstansiyon kaybı açısından gruplar arasında anlamlı fark saptanmadı (p=0.801). Son kontrolde rezidüel ekstansiyon kaybı konservatif tedavi grubunda anlamlı derecede daha yüksek bulunurken (medyan 4°), cerrahi gruplarda daha düşük değerler saptandı (0.5° ve 1°; p<0.001). Crawford kriterlerinin çok kategorili analizinde gruplar arasında anlamlı fark izlenmedi (p=0.095); ancak ikili analizde (mükemmel + iyi sonuçlar) cerrahi gruplarda başarı oranı konservatif tedaviye göre anlamlı derecede daha yüksekti (p=0.014). Konservatif tedavi grubunda cilt maserasyonu daha sık görülürken (p<0.001), pinle ilişkili irritasyon pinin dışında bırakıldığı grupta daha yüksek oranda izlendi (p=0.006). Gruplar arasında yüzeysel enfeksiyon açısından anlamlı fark saptanmadı.

**SONUÇ:** Akut tendinöz çekiç parmak olgularında perkütan IM K-teli ile DIP eklem transfiksasyonu, konservatif tedaviye kıyasla daha iyi ekstansiyon kontrolü ve daha yüksek fonksiyonel başarı oranları sağlamaktadır. Pin konfigürasyonu fonksiyonel sonuçları belirgin biçimde etkilememekle birlikte, hasta konforu ve komplikasyon profili üzerinde etkili olmaktadır. Tedavi seçimi hasta uyumu ve fonksiyonel beklentiler göz önünde bulundurularak bireyselleştirilmelidir.

**Anahtar sözcükler:** Akut tendinöz çekiç parmak; distal interfalangeal eklem; intramedüller K-teli; DIP transfiksasyonu; konservatif tedavi; perkütan pinleme.

*Ulus Travma Acil Cerrahi Derg* 2026;32(6):702-714 DOI: 10.14744/tjtes.2026.18598